Commentary

DIGITAL PHOTOGRAPHY AND COMPUTERISATION IN ORTHOPAEDICS

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INTRODUCTION

Clinical documentation is an important part of a surgeon's work and very few papers have described its application to orthopaedic surgery[1,2]. Digital photography is particularly of photographic documentation suitable in specialized areas such as the hand or foot because of the discrete regional anatomy and radiology. For many years, 35 mm negative and slide photography have been the standard means for photographic records. This is a familiar technique producing high – quality images. The advantages are the higher costs of films and slides, the time lag between photography and development of the film, significant wastage of film in achieving the best exposure, the labour and time needed to sort slides, the space required for storage, and most importantly, the deterioration in the quality of the images with time. In the early 1980s, the first digital camera was introduced and there have since been rapid advances in the technology of digital imaging. The reduced cost of digital cameras, computers and software has allowed the acquisition of clinical material in the form of electronic media to become an affordable and convenient alternative to conventional 35 mm photography[3-5]. The application of digital technology for filmless radiology using a picture archiving and communication system (PACS) is already beginning to influence the practice of orthopaedic surgery.

This article describes the co-ordinated use of digital photography, computer and database software for clinical documentation, audit, information sharing and research in orthopaedics.

DIGITAL IMAGING

In digital photography, the image is captured using charge coupled sensor devices (CCD) that record light. The range of CCD light sensitivities as opposed to film is enormous and particularly well suited for the challenging environment of X-ray and intra-operative photography. The image is converted into a binary digital code and can be viewed on the camera's liquid crystal display (LCD) screen immediately. Most digital images are stored using image compression which makes the files more manageable with minimal loss of picture quality. Image compression formats which are commonly used include Joint Photography Expert Group (JPEG)[5,6] and Graphic Interchange Format (GIF). For clinical purpose, JPEG is preferred since GIF gives significantly bigger files, requires more memory space and is slower to pressed file which is even slower to process and occupies more memory space. The phenomenon of slight diminution of the quality of the image, when JPEG pictures are opened or closed, should encourage the maintenance of an unedited picture as the archive/backup copy. The advantages of digital photography in clinical practice are:

- Instant preview of the image on the LCD display[6,7] of the camera allows pictorial editing of composition, brightness and clarity of the images.
- The images are immediately available for the purpose of surgical planning or case discussion.
- The images can be stored and organized directly into a computer database, facilitating easy retrieval and integration.
- Incorporation of digital images into the patient's case file (e.g. a floppy disc and a re-writable CD)[7,8] provide legal documentation of the nature and severity of injury, as well as assistance in surgical management.
- In the absence of the original X-ray, pre-captured images can provide information for pre-operative management.
- Transmission of the images via electronic mail or direct phone line is useful in a medical emergency, such as a motor vehicle accident[7] or to facilitate specialist clinical opinion in long – distant consultation[8].
- Diagnosis may be improved when clinical digital images are sent with pathology specimens[9].
- It facilitates teleconference or internet conference with expert.
- Educational and academic presentations are facilitated by incorporating digital images in commonly used computer presentation software, such as Microsoft PowerPoint™ of Microsoft Corporation (www.microsoft.com).

CHOICE OF EQUIPMENT FOR DIGITAL PHOTOGRAPHY

Digital cameras: There are many digital cameras available in the market and their resolution, storage capacity and optical stabilization are improving by the time. The following features are the minimum requirement in clinical practice for individual surgeons:

- Resolution of 2.1 to 3.2 mega pixels will usually be adequate. With software enhancement, it may be possible to enlarge an image to more than 8 inches x 10 inches with minimal loss of clarity. The more expensive cameras with 4.3 x 5.5 mega pixels are not usually needed and their higher resolution will also demand a larger storage capacity.
- A macro lens, either built in or external is essential for close-up photography.
- An optical stabilizer is needed to prevent camera shake.
- An image magnification or zoom facilities may be either optical or digital. Optical zoom is identical to the performance of zoom lenses used in 35 mm film cameras. Digital zoom is created by enlarging the image off the CCD sensor. It is similar to enlarging from a negative and may lose image quality.
- Rechargeable batteries are more economical. Having a fully charged spare battery is essential for clinical work as digital cameras consume battery power rapidly especially in the viewing mode.
- Size and robustness are important considerations. A bulky camera is more stable but less portable, whereas a camera which is too light may cause camera shakes. Irrespective of size, the camera must be robust enough to sustain minor accidents.
- Some newer cameras have the capability of a short video capture usually up to 30 seconds. The resolution is acceptable in cameras which use a larger memory storage medium such as a memory stick, but it is generally poor in those using floppy discs.

Storage medium: A digital camera processes the image which is altered and compressed prior to storage. The film for the digital camera is its storage medium. The most commonly available types include:

- Floppy diskettes which store up to 1.3 megabytes (MB) e.g. Sony FD Mavica (www.sony.com).
- Removable memory type devices available in sizes from 8 to 512 MB are used in the majority of compact digital cameras.
- Compact Flash™ (www.compactflash.org) is the oldest, most robust and widely used type of memory and has 512 MB of memory.
- Smart Media™ (www.smartmedia.com) cards are of similar size to Compact Flash, but thinner and less robust with a maximum capacity of 256 MB.
- Memory Stick™ is a proprietary storage card used only by Sony cameras and their other products. It is similar, but only half as fast as Compact Flash with capacities from 16 to 128 MB.
- Rewritable 8 cm CD (CD-RW) has a storage capacity of 156 MB, but can only be used with the Sony CD Mavica™ camera.

The authors have also chosen a digital camera which uses floppy discs rather than memory cards for the following reasons:

- Sorting the images stored on memory cards is time consuming and inefficient similar to processing rolls of clinical film. The larger the memory capacity of the card, the longer it takes to sort out.
- Pre-operative, intra-operative and post-operative images captured on a floppy disc may be easily kept within the patient's file or record until the completion of treatment before being archived to a dedicated computer.
- An 8 cm CD-RW is significantly more expensive than a floppy disc and requires computers which can read the small CDs. The cost of the cameras using 8 cm CD-RW is also much higher.
- The limitation of the floppy disc is the file size. This may be managed by adjusting the image resolution with a low resolution for the patient's identity label and a higher resolution for the detailed anatomy. Most clinical images may be captured on 640x480 pixels file size. At this resolution a floppy disc can store between 24 and 40 images.

TECHNIQUE OF DIGITAL PHOTOGRAPHY

To put the subject in perspective, a global overview shot is advisable before a close up shot. Flash and theatre lights are generally not necessary with digital cameras and indeed, can often cause over- exposure and colour distortion. It is important to confine the picture to one type or subject in order to avoid distraction and a simple blue or green background is suitable for focusing. When photographing radiographs[5,6], it is important to use black and white wettings on the digital camera to avoid colour fringe effects from the lighting source. It is essential to obtain informed consent for all aspects of digital photography in a clinical setting. Similarly, protecting the confidentiality of patients by avoiding images that could identify the individual must be standard practice. This is particularly important when images are to be used for publication, research, teaching, or case discussion. Data protection is another important consideration. This may be achieved by using commercially available data protection software programs to prevent unauthorized access and data transfer, either manually or electronically.

Digital photography has revolutionized the way we

document and store clinical information. It allows important clinical material, especially images to be documented, archived and retrieved with ease. A reliable filing program and a fast computer are preferable[2,5].The initial costs are unavoidable but will be set against the savings on film or slide processing charges, as well as minimizing wastage. The information, once stored and archived, will be preserved indefinitely, to be used for teaching audit and potential research purposes.

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